



Video tutorial: Measuring blue intensity with the CooRecorder software application

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ABSTRACT

Blue intensity (BI) techniques offer a cost-effective, tree ring parameters that are representative of densitometric ring growth and are increasingly being integrated in the various fields of dendrochronology. Particularly, the refinement and application of latewood blue intensity (LWB) is particularly popular within the field of dendroclimatology. In an effort to broaden accessibility of BI methods and to provide teaching and training material for dendrochronologists aiming to use BI methods, we present a brief overview of how to obtain LWB data from tree rings using the CooRecorder (Cybis Elektronik & Data AB) software application. The video tutorial (closed-captioned in English) can be found here: <https://www.youtube.com/watch?v=0kysVZuvf6Q> and via Mendeley Data: doi: 10.17632/83xt6hr9jp.1

1. Introduction

Tree ring parameters that provide representative measures of densitometric growth, as opposed to radial growth, served as important contributions to the field of dendrochronology over the last several decades. Gaining popularity in the 1980s, the X-ray-based parameter, maximum latewood density (MXD; Schweingruber et al., 1978) was critical for broadening and strengthening the coverage of temperature-sensitive tree ring records in the Northern Hemisphere. Although MXD is a widely advantageous parameter for dendroclimatology, the cost and labor-intensive nature of obtaining MXD data are often prohibitive to many research individuals and institutions. Blue intensity (BI) is a technique resulting from efforts to develop a more cost-effective surrogate parameter for MXD using the reflectance and brightness properties of wood (Sheppard et al., 1996; McCarroll et al., 2002). BI methods use visible light-based equipment such as scanners or cameras with dedicated software to measure the amount of blue spectrum light that is absorbed across an annual growth ring. As raw latewood BI measurement data are inversely correlated with MXD (a dense, dark latewood will express low reflectance), the raw latewood BI data are typically inverted, resulting in what is commonly known today as latewood blue intensity (LWB).

The application of BI methods, particularly producing the LWB

parameter, have become increasingly popular within the tree ring community over the last two decades (Kaczka and Wilson, 2021). However, despite the commonality of studies that employ this technique, most studies only provide coarse characterizations of how the BI data were collected (Appendix A). Further, given that BI methods are novel and many aspects are still widely unexplored, more studies are needed to evaluate the application of BI methods across different regions.

With the aims of increasing the accessibility to BI methods within the field of dendrochronology, here, we present a video tutorial that demonstrates the basic methods involved with acquiring LWB data from tree rings using the software application CooRecorder (Cybis Elektronik & Data AB, Sweden; <http://www.cybis.se/forfun/dendro/>). CooRecorder is a relatively inexpensive software application that allows users to obtain tree ring metrics (e.g. ring-width, BI) by placing and reading spatial coordinate files on high resolution scanned images of tree ring samples. CooRecorder is paired with a complimentary software application called CDendro. The two programs are used in conjunction to obtain, manage, organize, and crossdate tree ring data. After coordinate and data files are created in CooRecorder, data collections can be compiled, managed, and exported using CDendro.

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2. Tutorial overview

This tutorial targets users within the field of dendrochronology who are familiar with measuring tree ring widths but are new to BI methods. Users should be aware that several steps are required before BI data collection can commence in CooRecorder. First, samples must be prepared such that users obtain a flat, smooth wood surface, and the annual rings are clearly visible. For some species, sample preparation may include chemical-based resin extraction and stain removal (Rydval et al., 2014; Wang et al., 2020). Second, ring boundaries should be delineated. CooRecorder uses point placement to calculate ring width by calculating the distance between successive X,Y coordinates. The same X,Y points used to delineate ring boundaries are associated with a data collection frame, the bounding area from which BI data are generated. As such, prior to BI data collection, users should ensure that ring boundaries are precisely and accurately placed. While this tutorial offers a few general guidelines pertaining to proper ring placement for BI methods, we do not comprehensively cover sample preparation or the basic use of CooRecorder or CDendro for ring delineation and ring-width data acquisition, as users are directed to multiple tutorial videos covering this topic by Maxwell and Larsson (2021), or the software help website (<https://www.cybis.se/forfun/dendro/helpcoorecorder7/-bluechannel80/index.htm>).

In this tutorial, we used already-prepared samples of Engelmann spruce (*Picea engelmannii*) that have been shaved with a core microtome (Gärtner and Nievergelt, 2010) and fine-polished with 30 µm sandpaper. Following preparation, samples were scanned in 24-bit color and at 3200 dpi resolution on an Epson 12000XL large-format scanner, (Epson America Inc.) calibrated with the Silverfast® Ai Studio (ver. 9) software application. Rings boundaries were delineated in CooRecorder such that seasonwood boundaries (latewood versus earlywood) were placed for each sample. The accompanying scanned images and measurement position files referenced in this video are included in Appendix A so that viewers have the option of following along throughout the tutorial.

The key functions covered in the tutorial are as follows:

- Guidelines for delineating ring boundaries prior to BI data collection.
 - Learning about color intensity (CI) collectors.
 - Defining CI parameters.
- window width (w), offset (f), depth (d) and percent of dark latewood (% latewood)
- Adjusting key CI parameter settings to optimize BI measurements.

- Visualizing how changes in CI settings impact BI measurements.
- Generating and applying BI measurements to delineated rings.
- Dealing with data integrity issues (e.g. gaps, rot, resin content, color changes).
- Quality control of data generation.
- Saving and exporting BI data.

Declaration of Competing Interest

The authors declare no financial interests/personal relationships which may be considered as potential competing interests.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.dendro.2022.125999](https://doi.org/10.1016/j.dendro.2022.125999).

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